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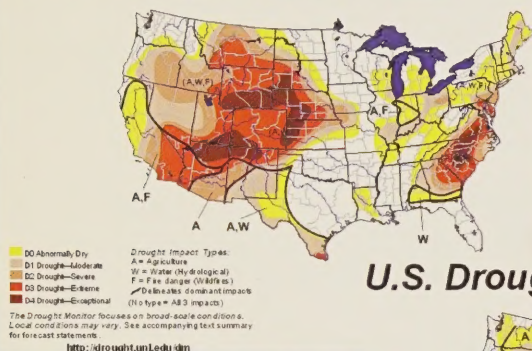


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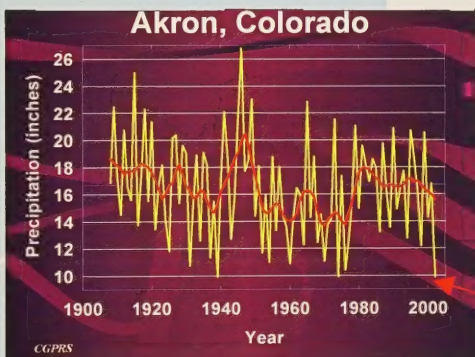
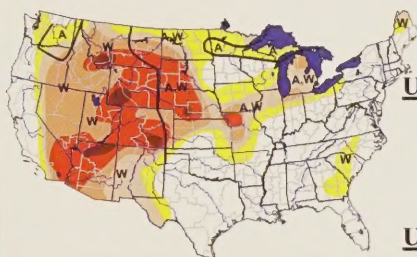
Central Great Plains Research Station

2002 Research Progress Report

U.S. Drought Monitor August 6, 2002



U.S. Drought Monitor January 7, 2003



2002

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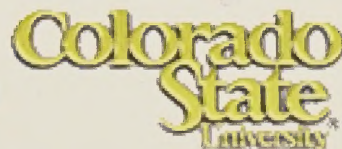


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CENTRAL PLAINS RESOURCE MANAGEMENT RESEARCH UNIT

MISSION STATEMENT

To enhance the economic and environmental well-being of agriculture by development of integrated cropping systems and technologies for optimal utilization of soil and water resources. Emphasis is on efficient use of plant nutrients, pesticides, and water and soil conservation/preservation.

CENTRAL GREAT PLAINS RESEARCH STATION STAFF

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SUMMARY OF 2002 WEATHER

CENTRAL GREAT PLAINS RESEARCH STATION AKRON, COLORADO

R. Wayne Shawcroft

Regional Extension Irrigation Agronomist (Retired)

Farm Service Representative, Citizens National Bank of Akron

Driest Year on Record! A summary of the **Year-2002** weather has to begin with this headline. The drought for the entire region has to headline the discussion about the **Year-2002**. This, unfortunately, has to be the same for the weather summary for the Research Station. The **9.49 inches** precipitation total for this year breaks the previous “all-time” low of **9.93 inches** logged in both **1939** and **1974**. The spring and summer months were extraordinarily dry, with **July** also setting a **new record low** of only **0.10 inches**.

Temperatures were a little erratic. The most severe heat came in June and July, accompanying the low rainfall in those months, but the heat did drop off somewhat in August and September. The summer heat was enough to aggravate the dry conditions. The wheat crop, although damaged by the drought, did yield better than anticipated, but summer crops i.e. corn, millet, sunflowers, and hay crops were almost none existent, either not being planted or abandoned. Pasture conditions were very poor, which led to a major sell-off of cattle. All in all, this was one of the poorest, most severe crop and livestock production-year on record.

TEMPERATURES

Monthly mean, maximum, and minimum temperatures are shown in Tables 1, 2, and 3 (also see the graph of the Monthly Mean). January started out about normal with highs in the low 30's and even a -3°F reading on Jan. 2, but warm, dry conditions occurred with highs in the 60's by the 8th, 9th, and 10th. A new record high for the date of 69°F was set on the 8th. Temperatures moderated somewhat, but were back in the high sixties near the end of the month. A few single-digit lows were associated with some light snow flurries around the 23rd and the 31st. January averaged about 4.0°F above average for the mean temperature. The same trend continued through February until a cold period on the 26th, when a high of only 12 and a low of -3 were recorded.

The month of March developed into a very cold month, with a low of -11 on the 2nd. The daily minimums for March averaged only 16.6°F , which ranked as the fifth lowest average for minimum temperatures in March. The mean temperature in March was 4.3°F below the average. This relatively cold March may have been a *blessing in disguise* for the wheat crop, since this delayed the break of winter dormancy and may have preserved some moisture for the crop in later months. The extraordinarily warm temperatures returned in April, with new daily record highs and lows set on the 15th and 16th. Overall, April was 2.8°F above average for the mean. Cooler temperatures returned in May, with several new daily record minimum temperatures set on the 9th, 23rd, 25th, resulting in an average mean just slightly below the average. Temperatures of 94 and

66 (a new record low for the date) for the high and low on the 31st indicated that the heat was about to return.

June brought very warm temperatures, with six new daily records being set (3 new highs, 2 new low, and 1 new mean record). There were two 100 ° F days, and a string of ten 90 or above days from the 21st through the 30th. The average maximum for June was **89.90 ° F**, which is a **new record average maximum temperature**. Overall, the mean temperature for June of 72.48 ° F ranked as the **third warmest June** on record. This heat continued through July, with July logging **six 100 ° F –plus** days, with an average daily high of 94.00 (5th highest on record) and a average mean of 76.50 ° F (10th highest on record). Several stretches of eight or nine days in a row of 90+ heat continued into mid August. August 16 logged a 103 ° F (a new record for the date), but interestingly enough, a cold front came through and a new record low for the date of 45 ° F was set the following morning on the 17th. This signaled the end of the oppressive heat, since the remaining part of August brought cooler and more moderate temperatures. The average for the month was only 0.45 ° F above average.

September brought cooler temperatures, with more *fall-like* readings. There were no freezing temperatures in September however. See Table 4 for a summary of the temperature regime for the summer months. The first freezing temperature did not come until October 12 with a 31° F reading. October and November brought colder than average temperatures with highs averaging much below normal, but surprisingly no below-zero readings. Unseasonably warm temperatures returned in December, with an average mean 5.15 degrees above average, and again with no below-zero readings. The coldest temperature in December was a +4 ° F on the 26th.

The **average annual mean temperature** (an average of the daily mean for the 365 days of the year) as shown in the “**Annual Mean Temp.**” graph was **49.64 ° F**. This ranks **2002** as the **19th warmest** year on record. For comparison the warmest year on record was 1934 with an average of 52.62 ° F, and the coldest 1912 with an average of 44.81 ° F.

A summary of the **Growing-Degree-Days (GDD)** for the May through September period is shown in **Table 4**. This was 10.3% above average for the season, and ranked as the **13th highest GDD** accumulation of the 95-year record. The **GDD** accumulation graph shows that the summer was below average until late May and then began a rapid steady rise with the heat of June and July, finally moderating and leveling off somewhat in late August and into September. About 60% of the seasonal GDD accumulation came in June and July. The average percentage for these months is about 48%.

PRECIPITATION

The **annual total precipitation** for 2002 was **9.49 inches**, which ranks as the **DRIEST YEAR OF THE 95-YEAR RECORD**. The **May-Sept. period** total was only **7.30 inches** compared to the **11.44 inches** average. The *Monthly Totals* are shown in **Table 5**. Nine months (Jan.-Jul. and Nov.-Dec.) had rainfall below the average, while three months (Aug.-Oct.) had above average rainfall. A **new record low total** of **0.10 inches** was logged in **July**. The previous record for July was 0.31 inches in 1934. An examination of Table 5, shown more dramatically in the graph of the monthly rainfall totals, shows how extraordinarily dry it was during the first half of the year. Quite often a

dry month will occur in the spring months, but more than likely a subsequent month will log a greater amount. This was not the case in 2002. All months through July were severely below average. The cumulative total through July was only 3.09 inches or 27.5% of the average of 11.22 inches. This even continued into late August until a series of severe thunderstorms with hail and winds on the evening of Aug. 24. This storm brought heavy rain to many areas and hail damage was severe on crops already suffering from drought.

With the rains in late August and some generally beneficial rains from the 9th through the 12th of Sept., the wheat-planting operation proceeded about normal. These rains also caused some pasture and grass “green-up” for the first time all summer. The first substantial winter-type precipitation came in a series of snowstorms from Oct. 23 through Nov. 5, which logged nearly 11 inches of total snowfall. However, warm, mild temperatures resulted in the melting of this snow by Nov. 9th. After that time, warm, mild temperatures and no significant snowfall occurred for the remainder of the year.

The snowfall log shows a total *calendar year* total of 18.5 inches of snow with only 1.27 inches of precipitation. This is substantially below the rough average of about 30 inches of snow per winter.

Drought conditions appear to be continuing into the 2003 year. In summarizing the prevailing conditions from year to year, drought conditions can usually be found in some regions, on an isolated basis, in about every year. This drought is so wide-spread and severe for such a large area, and has created major concern and hardship for many.

The following tables and graphs show other features of the 2002 weather year, and compare the 2002 season with the long-term record. This completes the 95th year of compilation of daily rainfall and temperature records at the Research Station.

Special note – After retiring in Nov. 2001, **Bob Florian** passed away in Feb. 2002. Bob had been the weather observer and recorder for about 48 years, while at the Research Station. He is sorely missed! RWS

TABLE 1. AVERAGE MONTHLY MEAN TEMPERATURES

(Based on 8:00 am daily observation time)

2002 TEMPERATURES

USDA-ARS RESEARCH STATION, AKRON, CO

MEAN TEMPS		95-YEAR		HIGH		LOW	
MONTH	2002 AVERAGE	1908-2002 AVERAGE	DEPARTURE	AVERAGE	(YEAR)	AVERAGE	(YEAR)
JAN	29.44 °F	25.37 °F	4.06 °F	35.4	(1986)	7.8	(1937)
FEB	31.80	30.03	1.77	41.1	(1954)	16.0	(1929)
MAR	32.13	36.40	-4.27	45.5	(1986)	19.9	(1912)
APR	49.30	46.49	2.81	53.6	(1930)	35.9	(1920)
MAY	55.76	56.25	-0.49	65.3	(1934)	48.0	(1995)
JUN	72.48	66.62	5.86	73.5	(1956)	59.1	(1945)
JUL	76.50	73.40	3.10	79.9	(1934)	67.6	(1915)
AUG	71.95	71.51	0.45	77.0	(1983)	65.3	(1927)
SEP	62.90	62.35	0.55	68.4	(1998)	53.8	(1965)
OCT	44.92	50.28	-5.36	59.0	(1963)	40.7	(1969)
NOV	35.72	36.67	-0.95	45.8	(1949)	23.5	(1929)
DEC	32.76	27.67	5.09	36.3	(1980)	12.7	(1983)
YEARLY AVE							
MEAN TEMP	49.638 °F	48.5862 °F	1.052 °F	52.64	(1934)	44.81	(1912)

2002 Date included in Averages

ALL TEMPERATURES IN DEGREES F

MAX TEMPS

= New Records

TABLE 2. AVERAGE MONTHLY MAXIMUM TEMPERATURES

JAN	44.42 °F	38.12 °F	6.30 °F	49.6	(1934)	20.8	(1937)
FEB	47.89	42.87	5.02	56.0	(1954)	28.6	(1929)
MAR	47.65	49.70	-2.06	60.6	(1972)	28.7	(1912)
APR	66.10	60.58	5.52	69.9	(1908)	45.7	(1920)
MAY	72.52	70.07	2.44	81.9	(1934)	57.5	(1995)
JUN	89.90	81.41	8.49	89.90	(2002)	70.0	(1928)
JUL	94.00	88.85	5.15	97.6	(1934)	81.2	(1915)
AUG	88.61	86.89	1.72	93.8	(1937)	77.5	(1927)
SEP	77.77	77.99	-0.22	85.8	(1998)	65.6	(1965)
OCT	59.39	65.74	-6.36	75.1	(1963)	50.8	(1969)
NOV	47.70	50.36	-2.66	62.2	(1949)	33.0	(1929)
DEC	47.03	40.27	6.76	51.6	(1957)	22.4	(1983)
YEARLY AVE							
MAX TEMP	65.248 °F	62.738 °F	2.510 °F				

MIN TEMPS

TABLE 3. AVERAGE MONTHLY MINIMUM TEMPERATURES

JAN	14.45 °F	12.63 °F	1.83 °F	22.9	(1953)	-5.3	(1937)
FEB	15.71	17.20	-1.49	26.6	(1992)	2.2	(1936)
MAR	16.61	23.10	-6.49	30.9	(1986)	11.0	(1912)
APR	32.50	32.40	0.10	39.3	(1930)	26.1	(1920)
MAY	39.00	42.42	-3.42	48.6	(1934)	36.5	(1917)
JUN	55.07	51.82	3.24	57.7	(1956)	46.0	(1945)
JUL	59.00	57.96	1.04	62.6	(1966)	54.1	(1915)
AUG	55.29	56.12	-0.83	60.8	(1983)	52.2	(20&74)
SEP	48.03	46.72	1.31	52.6	(1963)	41.2	(12&45)
OCT	30.45	34.81	-4.36	43.0	(1963)	28.9	(1917)
NOV	23.73	22.98	0.75	29.4	(1998)	14.0	(1929)
DEC	18.48	15.06	3.42	21.9	(1946)	3.1	(1983)
YEARLY AVE							
MIN TEMP	34.028 °F	34.434 °F	-0.406 °F				

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**TABLE 4. SUMMER GROWING SEASON RAINFALL, TEMPERATURE, AND GROWING DEGREE-DAY SUMMARY
FOR USDA-ARS RESEARCH STATION, AKRON, COLORADO [2002 & 95-AVERAGE]**

RAINFALL inches			TEMPERATURE DATA MAY-SEPT. 2002									
			AVERAGE		GROWING		NUMBER OF DAYS 90 or ABOVE; 100 or Above; 55 or BELOW					
			MEAN TEMP Deg F		DEGREE-DAYS**		AKRON -- 2002			AKRON 95-YR AVE		
			2002*	AVG*	2002*	AVG*	90+	100+	<55	90+	100+	<55
MONTH	2002*	AVG*	2002*	AVG*	2002*	AVG*	90+	100+	<55	90+	100+	<55
MAY	0.55	2.96	55.76	56.25	212.5	235.9	1	0	30	1.0	0.0	30.4
JUN	1.71	2.45	72.48	66.62	674.5	501.8	18	2	16	7.7	0.6	21.7
JUL	0.10	2.67	76.50	73.40	821.5	725.6	22	6	6	16.2	2.1	8.6
AUG	3.44	2.12	71.95	71.51	680.5	666.8	16	2	15	13.7	0.8	13.1
SEP	1.50	1.25	62.90	62.35	390.5	389.0	5	0	22	4.9	0.1	26.5
TOTALS	7.30	11.44	67.92	66.02	2779.5	2519.1	62	10	89	43.4	3.6	100.4
	Dep.=	-4.14	Dep.=	1.90	Dep.=	260.4	40.5%	6.5%	58.2%	28.4%	2.3%	65.6%

* 95-year average rainfall and temperature data(1908-2002); and number of days 90 or above, 100 or above, and 55 or less, at Central Great Plains Res. Sta., Akron, Colorado
 ** GROWING DEG-DAYS defined as number of days with daily mean temperature above a 50-degree F base. For example. Max = 85; Min = 53; Mean = (85+53)/2=69. Deg-Day unit = 69 - 50 = 19 GDD units.
 AKRON GDD UNITS ACCUMULATED FROM MAY 1 THROUGH SEPT. 30.

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TABLE 5. RAINFALL AMOUNTS BY MONTHS. USDA-ARS, AKRON, COLORADO

2002 RAINFALL SUMMARY

(Based on 8:00 am daily observation time)

MONTH	2002 TOTAL	95-YEAR AVE AVE. 1908-2002	DEPART.	% OF AVERAGE	HIGH TOTAL (YEAR)	LOW TOTAL (YEAR)	2002 CUM	95-YR AV CUM	DEPART. CUM	% OF AVERAGE	MON
JAN	0.09 inches	0.33 inches	-0.24	27.0%	1.51 (1988)	0.00 (6 YRS)	0.09	0.33	-0.24	27.0%	JAN
FEB	0.06	0.34	-0.28	17.4%	1.68 (1915)	0.00 (9 YRS)	0.15	0.68	-0.53	22.1%	FEB
MAR	0.08	0.83	-0.75	9.7%	3.06 (1909)	0.00 (1908)	0.23	1.51	-1.28	15.3%	MAR
APR	0.50	1.64	-1.14	30.5%	5.19 (1915)	0.17 (1928)	0.73	3.14	-2.41	23.2%	APR
MAY	0.55	2.96	-2.41	18.6%	7.79 (1917)	0.13 (1974)	1.28	6.10	-4.82	21.0%	MAY
JUN	1.71	2.45	-0.74	69.7%	6.11 (1965)	0.19 (1952)	2.99	8.55	-5.56	35.0%	JUN
JUL	0.10	2.67	-2.57	3.7%	7.22 (1946)	0.10 (2002)	3.09	11.22	-8.13	27.5%	JUL
AUG	3.44	2.12	1.32	162.6%	7.36 (1918)	0.16 (1973)	6.53	13.34	-6.81	48.9%	AUG
SEP	1.50	1.25	0.25	120.4%	4.83 (1950)	0.00 (1978)	8.03	14.59	-6.56	55.1%	SEP
OCT	1.04	0.91	0.13	114.1%	3.71 (1993)	0.00 (3 YRS)	9.07	15.50	-6.43	58.5%	OCT
NOV	0.39	0.56	-0.17	70.1%	2.67 (1946)	0.00 (3 YRS)	9.46	16.05	-6.59	58.9%	NOV
DEC	0.03	0.40	-0.37	7.5%	3.27 (1913)	0.00 ('08,28,'02)	9.49	16.46	-6.97	57.7%	DEC
Total	9.49 inches	16.4565 inches	-6.97	57.7%	26.79 (1946)	9.49 (2002)	9.49	16.46	-6.97	57.7%	

LAST UPDATE>> 31-Dec-2002 < * thru this date = new records
 2002 Final Summary -- 2002 date included in averages

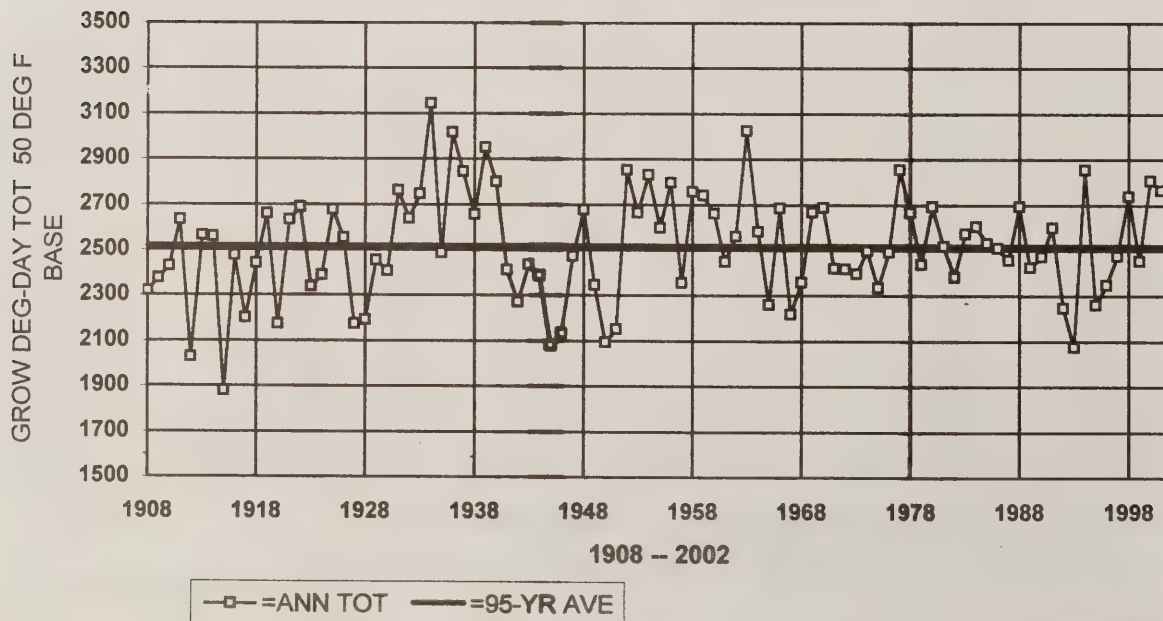
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Table 6. Snowfall Dates and Depths for Calendar Year 2002
USDA-ARS Research Station, Akron, Colorado

Period	DATE	Snow Depth inches	Precipitation inches
Winter01-02	Jan 1	Trace	Trace
Winter01-02	Jan 10	Trace	Trace
Winter01-02	Jan 23	1.50	0.05
Winter01-02	Jan 30 - 31	1.00	0.04
Winter01-02	Feb 9	Trace	0.02
Winter01-02	Feb 25	1.00	0.02
Winter01-02	Feb 28 -- Mar 1	1.00	0.02
Winter01-02	Mar 8	Trace	0.01
Winter01-02	Mar 14	Trace	0.01
Winter01-02	Mar 25	1.00	0.05
	Sub-Total	5.50	0.22
Winter02-03	Oct. 23 - Oct. 31	9.00	0.90
Winter02-03	Nov. 1 - Nov. 5	2.00	0.10
Winter02-03	Nov. 24	0.50	0.02
Winter02-03	Dec. 5	Trace	Trace
Winter02-03	Dec. 18	1.00	0.03
Winter02-03	Dec. 21	0.50	Trace
Winter02-03			
Winter02-03			
Winter02-03			
	Sub-Total	13.00	1.05
TOTALS -- Calendar Year		18.50	1.27

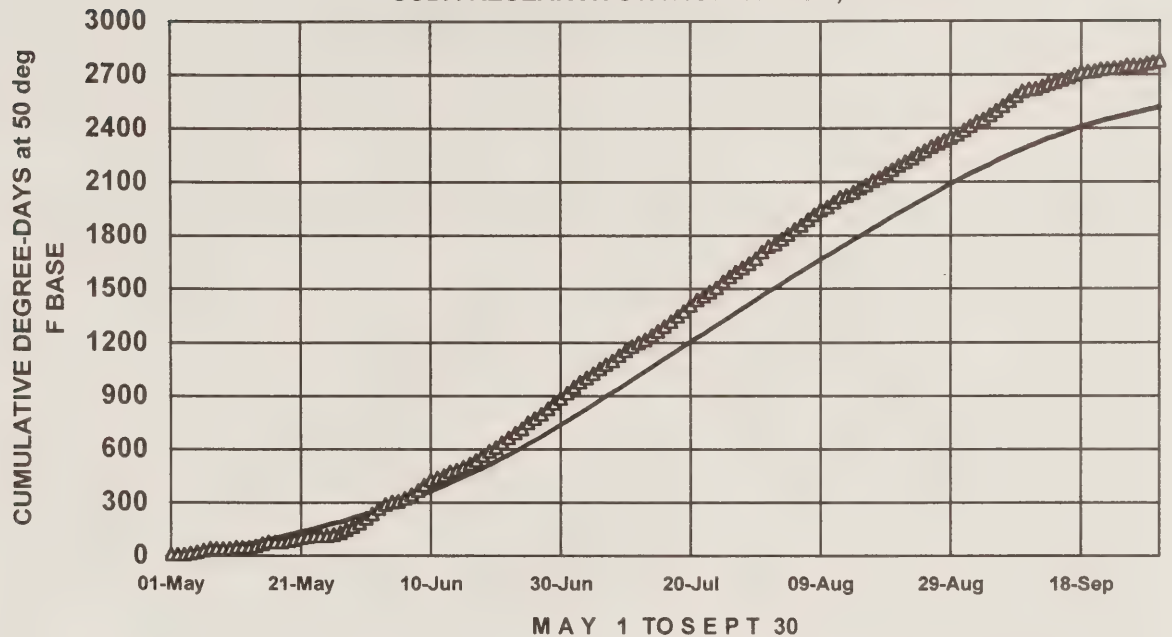
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GROWING DEGREE-DAYS (MAY-SEPT)
USDA-ARS RESEARCH STATION, AKRON, CO



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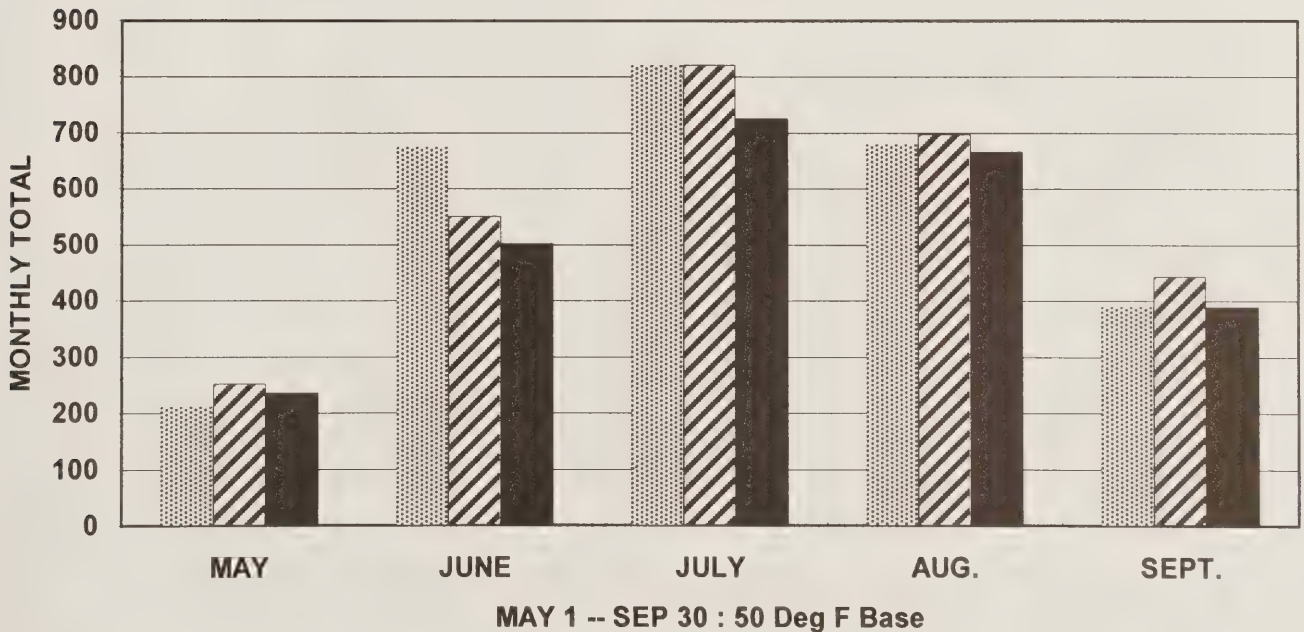
GROWING DEG-DAYS: 2002 & 95-YR AVE
USDA RESEARCH STATION AKRON, COLORADO



Gdd02.xls PRINTED: 02/01/2003

Δ =2002 —=95-YR AVE.

MONTHLY DEG-DAY TOTALS: 2002, 2001 & 95-yr Ave
USDA-ARS RESEARCH STATION, AKRON, CO

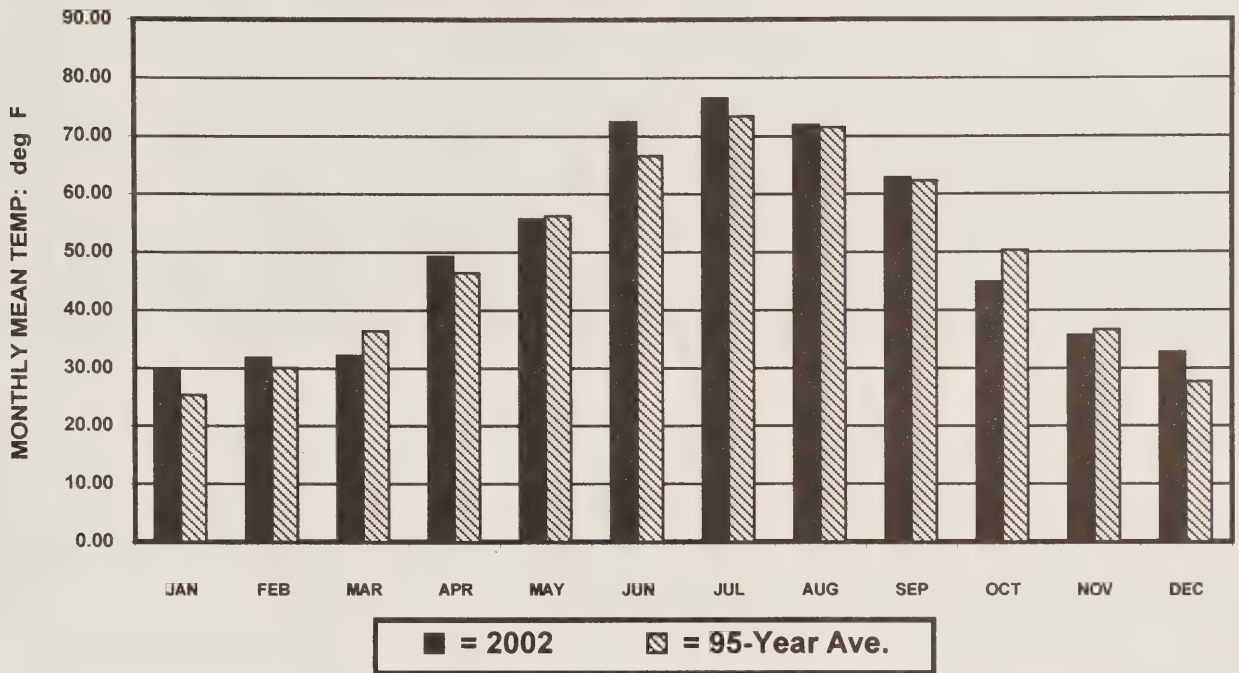


● 2002 ▨ 2001 ■ 95-yr av

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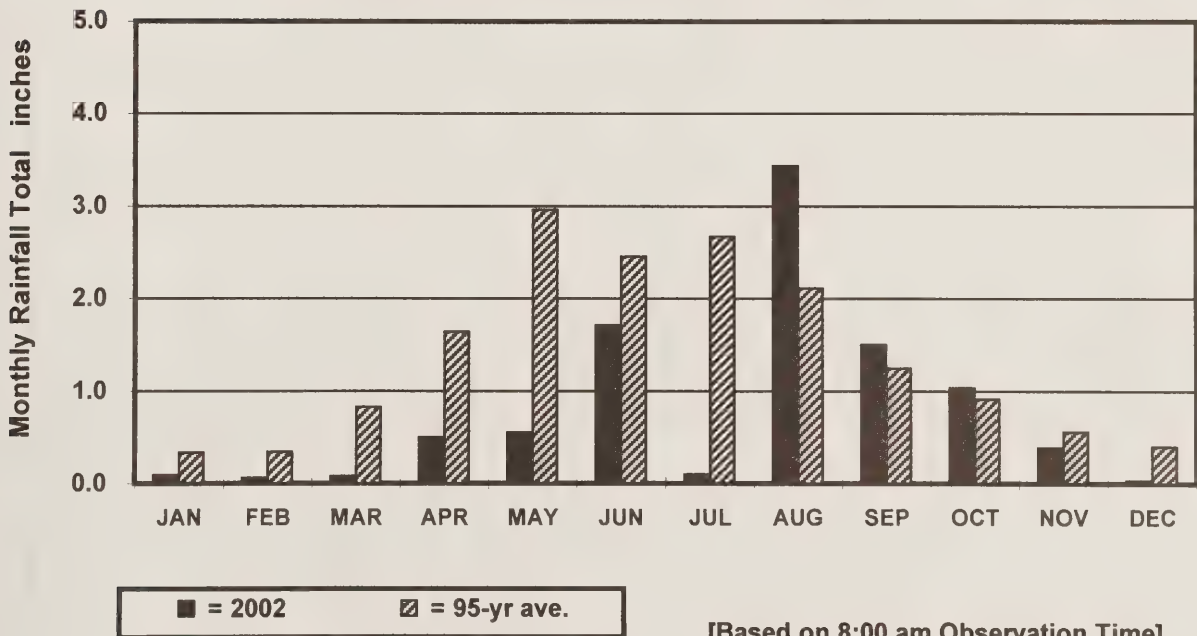
2002 RAINFALL													
CENTRAL GREAT PLAINS RESEARCH STATION AKRON, COLORADO													
PRECIPITATION LOG 2002 STANDARD GAUGE inches LOCATION: WEATHER STATION													
[Rainfall amounts are for the period 8:00 AM to 8:00 AM for the 24-hr period ending on the date recorded]													
DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	T		0.01								0.07		1
2					0.09		0.02			0.04	0.03		2
3													3
4						0.44							4
5	T					0.46		0.40		0.05		T	5
6													6
7					0.01								7
8			0.01	0.12									8
9		0.02						0.04	0.50	0.05			9
10	T								0.04				10
11					0.05	0.09							11
12									0.12		0.04		12
13									0.82				13
14			0.01								0.23		14
15													15
16													16
17					0.25								17
18				0.01								0.03	18
19													19
20		0.01				0.54							20
21			T									T	21
22								0.01					22
23	0.05					0.17				0.01			23
24								0.05			0.02		24
25		0.02	0.05		0.10			1.82					25
26						0.01			0.02				26
27				0.35				0.87		0.14			27
28		0.01		0.02			0.01			0.10			28
29					0.05		0.07	0.05		0.45			29
30	0.01							0.20		0.15			30
31	0.03									0.05			31
SUM	0.09	0.06	0.08	0.50	0.55	1.71	0.10	3.44	1.50	1.04	0.39	0.03	MONTHLY TOTAL
AVE	0.33	0.34	0.83	1.64	2.96	2.45	2.67	2.12	1.25	0.91	0.56	0.40	<<95-YEAR AVE
DEP	-0.24	-0.28	-0.75	-1.14	-2.41	-0.74	-2.57	1.32	0.25	0.13	-0.17	-0.37	DEPARTURE
%NORM	27.0%	17.4%	9.7%	30.5%	18.6%	69.7%	3.7%	162.6%	120.4%	114.1%	70.1%	7.5%	MONTHLY % OF NORMAL
CUM	0.09	0.15	0.23	0.73	1.28	2.99	3.09	6.53	8.03	9.07	9.46	9.49	CURRENT ACUM
AVCM	0.33	0.68	1.51	3.14	6.10	8.55	11.22	13.34	14.59	15.50	16.05	16.46	AVE ACUM
DEP	-0.24	-0.53	-1.28	-2.41	-4.82	-5.56	-8.13	-6.81	-6.56	-6.43	-6.59	-6.97	DEPARTURE
%of NORM	27.0%	22.1%	15.3%	23.2%	21.0%	35.0%	27.5%	48.9%	55.1%	58.5%	58.9%	57.7%	CUM % OF NORM
LAST UPDATE>>>													31-Dec-02
NOTE: NEW MONTHLY AVERAGE IS CALCULATED.....NEW AVERAGE INCLUDES 2002 RAINFALL DATA													
FINAL 2002 8:00AM TO 8:00AM LOG													

MONTHLY MEAN TEMP: 2002 & 95-YEAR AVE **USDA-ARS AKRON, COLORADO**



saved as: TEMP02a.XLS

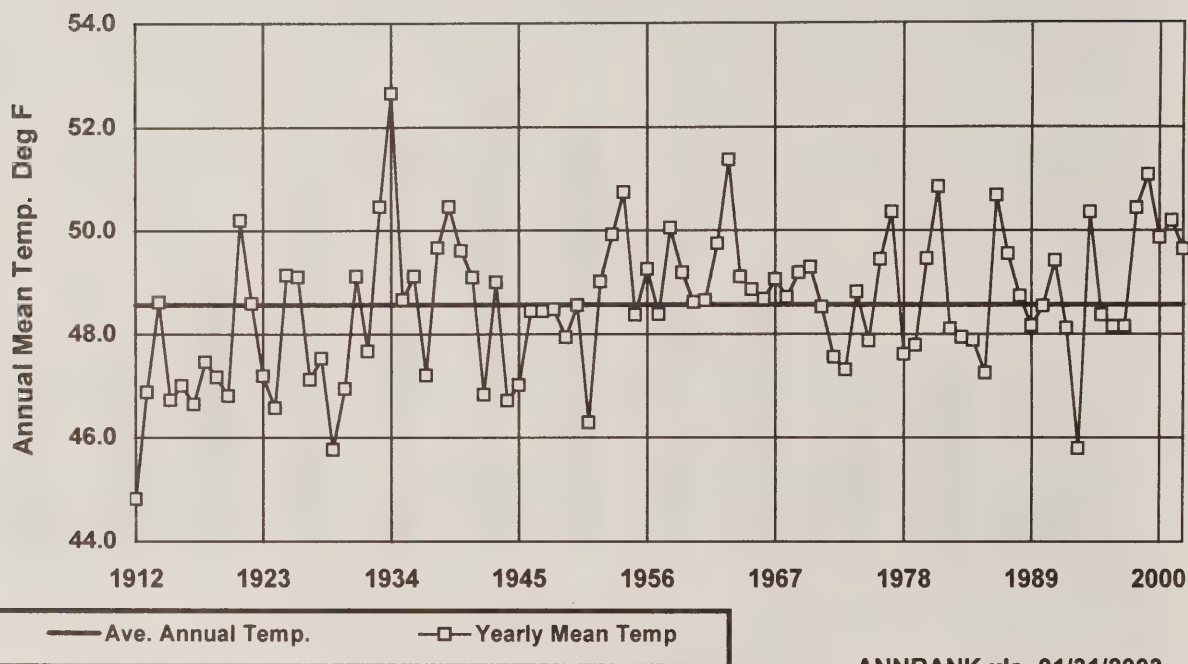
MONTHLY RAINFALL TOTAL 2002 & 95-Yr Ave inches **USDA-ARS RESEARCH STATION Akron, Colorado**



[Based on 8:00 am Observation Time]

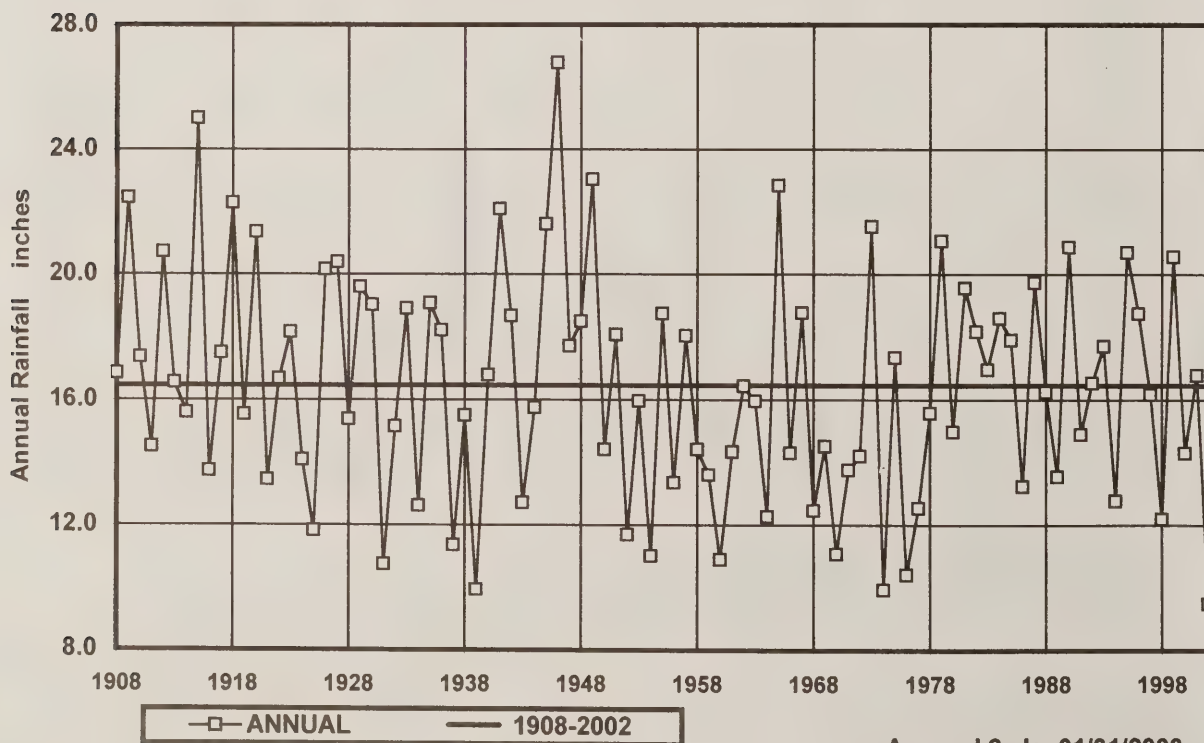
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ANNUAL MEAN TEMP. Deg F **USDA-ARS Research Station, Akron, Colorado**



ANNRANK.xls 01/31/2003

ANNUAL TOTAL RAINFALL 1908-2002 **USDA-ARS Research Station, Akron, Colorado**



Annrank2.xls 01/31/2003

A METHOD TO SEPARATE PLANT ROOTS FROM SOIL AND ANALYZE ROOT SURFACE AREA

J.G. Benjamin, D.C. Nielsen

PROBLEM: To study the effects of soil management practices on plant growth we need to investigate the effects of the soil environment on root growth. Studying soil management effects on plant root systems often is deterred by cost, in terms of time and labor, for collecting root samples, for washing the soil sample and for separating the live roots from previous years' roots and other organic debris. Methods that speed the process of washing soil from roots and that enable the researcher to quantify the amount of roots washed from a sample without the need to separate the roots from other organic materials in the sample, allow many more samples to be collected and processed for study.

APPROACH: We constructed a root washer for samples up to 4 inches in diameter and 9 inches long. As many as 24 samples can be washed at a time in about 1 ½ hours. We developed a method to determine the surface area of the roots from the sample without the need to manually separate the roots from soil debris. The washed samples are placed in a tray on a flat-bed scanner. The digital scan is accessed by a commercially-available image analysis software where the projected area of roots in the sample is manually measured. The projected area is then transformed into total root surface area.

RESULTS: Root area estimates from soil samples were accurate when a small enough grid size for the image analysis software was used. For this procedure, a grid density of 2 mm or less between lines was the most accurate, with a slope of the correlation line nearly 1 and an r^2 of 0.98. Removing debris from the sample was necessary only if the samples were very dirty. If the debris in the sample was greater than 20% of the projected area, measurement accuracy suffered due to occlusion of the plant root fragments by other materials. Partitioning of the sample into more than one scanning tray could be necessary to allow accurate measurements of the root materials in very dirty samples. Sample processing time was reduced from 20 hours per sample for hand separation of roots from debris to about 0.5 hour per sample when analyzing the image from an uncleaned sample.

FUTURE PLANS: We are using this technique to analyze root samples taken from studies on water use and productivity by legumes suitable for the semi-arid west. The speed of washing and measurement of root distributions allows more samples to be processed with the time and personnel available and will allow enough samples to be processed to decrease experimental error in statistical analysis.

USING LIMITED IRRIGATION FOR CROP PRODUCTION IN THE CENTRAL GREAT PLAINS

J.G. Benjamin, D. C. Nielsen, M. F. Vigil

PROBLEM: Irrigation water supplies in the central Great Plains of the United States continue to diminish due to use by farmers and additional demands for these water resources by urban areas. We envision that farmers will have less water available for irrigation in the future. Water resources need to be managed such that we maximize production for each unit of irrigation water. It is well recognized that there are critical periods during a crop's life cycle where minimizing water stress results in maximum yield. Several researchers have proposed limiting the application of irrigation water to these periods. Less is known about the long-term effects of limited irrigation on soil productivity and the sustainability of limited irrigation systems.

APPROACH: We continued an irrigation - tillage experiment that was started in 2000. An early snow and freeze in the fall of 2001 prevented the tillage treatments from being applied. The rotation plots in the experiment were planted to spring barley in 2002. The remaining plots were planted to corn. Half the field received full irrigation as determined from ET estimates and the other half of the field receiving no irrigation until the crop started to flower. After flowering the entire field received full irrigation based on estimated ET. Soil moisture content measurements using the neutron scatter technique were taken twice per week, immediately before irrigation and shortly after irrigation. The plant growth characteristics for corn and barley that were measured during the growing season included weekly leaf area index (LAI) measurements and biomass measurements at flowering and at maturity. All plots were harvested at maturity for grain yield. The tillage treatments were applied in the fall of 2002 by deep chiseling the tilled plots 14" deep.

RESULTS: The year 2002 was a very difficult year for this experiment. An extended drought occurred that subjected the crops to unusual water stress. Also, by being a relatively green area in a large region of brown, drought-stressed crops, we had much more wildlife damage than normal. In some plots deer and 13-striped ground squirrel activity reduced plant stands to less than 14,000 plants per acre from the 32,000 plant per acre usually planted. A hail storm occurred on August 24 which was at the R2 growth stage of corn. The LAI in the fully-irrigated corn plots was reduced from about 4 to about 2. The LAI in the partially-irrigated corn plots was reduced from about 2.5 to about 1. Crop yield was reduced accordingly. The mean corn yield for the fully-irrigated plots and the partially-irrigated, no-till plots were the same at about 80 bu/ac. The partially-irrigated, chisel plow plots had a grain yield of about 55 bu/ac. The fully-irrigated barley plots yielded about 55 bu/ac and the partially-irrigated barley plots yielded about 45 bu/ac.

FUTURE PLANS: We will continue the experiment in 2003. The crops will be corn in the continuous corn plots and sunflower in the crop rotation plots. We will install neutron access tubes in each plot to better evaluate water stress and irrigation efficiency. Other measurements of crop emergence, LAI, biomass, yield, and soil properties will remain the same. We are particularly interested in the cumulative effects of partial irrigation on the early plant growth when the current crop is planted on a soil depleted of water by the previous crop.

EFFECTS OF CROPPING ROTATIONS ON BENEFICIAL AND PEST INSECTS AT THE CENTRAL GREAT PLAINS RESEARCH STATION; AKRON, CO

M.D. Koch

PROBLEM: In 1986 the Russian wheat aphid *Diuraphis noxia* (Mordvilko) became a major small grains pest in Colorado. Control methods for this pest include cultural, mechanical, chemical, and biological. Russian wheat aphid control has been most effective using chemicals. However, producers may be able to combine cultural and biological techniques to decrease the need for other costly control measures. This would also diversify production on a given farm. Crops grown in close proximity to one another providing a year-long host of green vegetation may allow predators and parasites to survive and control pests. To test this theory, plots were established at three locations in eastern Colorado. Locations are near Briggsdale, Akron and Lamar.

APPROACH: The Akron, Colorado site was established in the spring of 1996. The previous crop was corn with a small area used for sunflowers. Crops being studied were selected by area production practices. The rotations being analyzed are: winter wheat-fallow; winter wheat-corn-fallow; winter wheat-corn-millet; and winter wheat-corn-sunflower-fallow. The individual plots for this location are relatively large, 90 feet wide by 180 feet in long. Experimental layout was in a complete randomized block with four replications. Every phase of the rotations is present each year in all four replicates. The wheat plots are divided in half lengthwise. One half is a susceptible variety and the other resistant to the Russian wheat aphid (RWA). The varieties used for 2002 were TAM 107 as the susceptible and Prairie Red as the resistant.

Table. Crop, variety, seeding rate, nitrogen rate and planting date for 2002 season.

<u>Crop</u>	<u>Variety</u>	<u>Seeding rate</u>	<u>N rate</u>	<u>Planting date</u>
Wheat	TAM 107	60 lbs/A	32 lbs/A	29 Sept. 2001
Wheat	Prairie Red	60 lbs/A	32 lbs/A	29 Sept. 2001
Corn	DK520RR	17.2K seeds/A	90 lbs/A	20 May 2002
Sunflowers	Triumph 765	17.2K seeds/A	56 lbs/A	10 June 2002
Millet	Sunup	12 lbs/A	26 lbs/A	13 June 2002

RESULTS - AGRONOMIC DATA: Precipitation was less than average for all crop seasons this past year. Moisture received for the wheat growing season of September 2001 through June 2002 accumulated just 5.95 inches. The average amount for this period is 11.73 inches. Spring crops also suffered from dry conditions. The 01 March 2002 through 31 October precipitation total was 7.88 inches as compared to an average of 13.97 inches.

Wheat yields ranged from a wheat-corn-sunflower-fallow rotation of TAM 107 at 22.04 bushels per acre to a low of a wheat-corn-millet rotation plot of Prairie Red at 2.85 bushels. Overall average of the plots was 10.38 bushels. TAM 107 averaged 10.28 and Prairie Red 10.49 bu./acre.

Corn yields were well below average for the Akron area this year. Hail stripped the leaves and damaged stalks of the suffering plants on 01 July. The plots were not harvested at this location. No grain was produced and the plants only grew to thirty inches in height.

Millet plots were not harvested this year. If not for the hail mentioned earlier, yields would have approached five to seven bushels per acre. The plants were short at seven inches in height and the heads were small at two or three inches. Grain production averaged only a few seeds per plant.

Sunflower yields were very low. Last year the wheat-corn-sunflower-fallow rotation yielded 1140 pounds. This year the average plot yield was slightly above 20 pounds per acre.

RESULTS - ENTOMOLOGICAL DATA: Since 1996, no insect populations have reached economic levels. Wheat pests were present in low numbers throughout the growing season. Mites and aphids were the prevalent insect pests. Russian wheat aphids *Diuraphis noxia* Mordvilko per 100 random tillers did not exceed three when put in Berlese funnels for 24 hours. Four aphids were caught through sampling. Of the four, one was found on TAM107. No Bird-cherry oat aphids *Rhopalosiphum padi* Linn or Greenbugs *Schizaphis graminum* Rond were found in the Berlese funnels after sampling. Onion thrips *Thrips tabaci* Linderman were found in low numbers during the growing season. Ladybird beetles and Lacewings were the primary predators in the wheat.

Pale western cutworms *Agrotis orthogonia* and Army cutworms *Euxoa auxiliaris* Grote were present in the Akron plots at slightly higher levels than the past few years. Total counts for three sampling dates showed one Pale western and 44 Army cutworms. Five random sites of one square foot were dug up per wheat variety to find the larvae. The highest population recorded was five per square foot. The average was 0.56 larvae per square foot.

Brown wheat mite *Petrobia latens* (Müller) infestations were very low this year. Sampling was performed with a Vortis insect sampler. A wooden stake was also used to compare populations. Thirty-one mites in a plot of wheat was the most observed throughout the growing season. The stake method seemed to show a higher density of mites when compared to the Vortis. Variability was high with both methods. There were few predatory mites observed this year.

Insect pests in corn were not of economic importance. There were eight cutworms found this year. Five were Pale western cutworms. The others were Army cutworms. Aphid species present were Greenbugs, Bird-cherry oat aphids, and Corn leaf aphids *Rhopalosiphum maidis*. Onion thrips were also noted but did not pose a threat to plant health. Corn earworm *Heliothis zea*, Corn rootworm *Diabrotica virgifera* LeConte and Sap beetles *Carpophilus lugubris* M. were all present in the plots. Only two Corn rootworms were found during sampling.

Greenbugs and Bird-cherry oat aphids were the only notable pest insects in the millet crop this year. The number of aphids was well below economic thresholds. Spiders were the main predators seen in the plots. Also, Ladybird beetles were present to help control the pests.

Three cutworms were found while sampling the four sunflower plots. No aphid species were present. Spotted sunflower stem weevil *Cylindrocopturus adspersus* Leconte did not cause any lodging. Sunflower head moth *Homoeosoma electellum* Hulst, Banded sunflower head moth *Cochylis hospes* Walsingham, and Red seed weevil *Smicronyx fulvus* Leconte were all present in low numbers. Seed head diameter was about two to three inches. Thus seed size was very small. Only two Grey seed weevil *Smicronyx sordidus* Leconte were noticed while sampling. Predators were scarce in this crop. Sampled plants throughout the growing season showed only one spider and no other beneficial insects.

FUTURE PLANS: This study is scheduled to continue several years. No changes to experimental design or layout are foreseen. Varieties and other agronomical and entomological inputs and data collection methods may vary depending upon new technologies or climatic influences.

2002 SUCTION TRAP DATA FOR AKRON, CO

M.D. Koch

The following is a table of the suction trap catches at the Central Great Plains Research Station located four miles east of Akron. Notice there were only 54 aphids caught this year among all species. Seven Russian wheat aphids were captured. For the second year, a flight of English grain aphids came through the end of August. Being in the field would get you covered with them. However, few of these aphids were high enough to be caught by the trap.

Table. Suction trap catches for Akron - 2002.

Location: Akron (Started 4-15-02) (Shut Down 9-27-02)								
Date	RWA	GB	BCO	CL	EGA	RGa	NON	NOTES
24 Apr	0	0	0	0	0	0	0	
29Apr	0	0	0	0	0	0	0	
06 May	0	0	0	0	0	0	0	
13 May	0	0	0	0	0	0	0	
20 May	0	0	0	0	0	0	0	
27 May	0	0	0	0	0	0	0	
03 June	1	0	0	0	0	0	0	
10 June	0	0	0	0	0	1	3	overflowed
17 June	5	0	0	0	0	0	0	
24 June	0	1	0	0	0	0	2	
01 July	0	0	0	0	0	0	7	overflowed
08 July	1	0	0	0	0	0	0	
15 July	0	0	0	0	0	0	0	
22 July	0	0	0	0	6	0	0	
29 July	0	0	0	0	1	0	0	
07 Aug	0	0	0	0	0	0	0	
14 Aug	0	0	0	0	9	0	3	
19 Aug	0	0	0	0	14	0	0	
26 Aug	0	0	0	0	0	0	0	overflowed
12 Sept	0	0	0	0	0	0	0	overflowed
TOTAL	7	1	0	0	30	1	15	

ECONOMIC INJURY LEVEL OF WINTER WHEAT VARIETIES TO THE RUSSIAN WHEAT APHID

M.D. Koch

PROBLEM: Russian wheat aphid *Diuraphis noxia* (Mordvilko) resistant hard red winter wheat varieties have been successfully introduced throughout the central Great Plains region. New varieties need to be tested before actual resistance in the field is known.

APPROACH: The experiment for 2002 compared a Russian wheat aphid (RWA) susceptible variety with three resistant varieties. Akron was the susceptible variety while Ankor, Halt and Stanton were the resistant. Experimental design was a split plot where infestation levels were grouped together for each replication. Eight replicates and three infestation levels were used. The infestation levels were 0x, 1x and 10x RWA. Infestation level 0x had a seed treatment of 8.3 ounces per hundred pounds of imidacloprid (Gaucho). They also were sprayed with 0.50 lb (AI) per acre of chlorpyrifos (Lorsban 4E-SG) on 14 May 2002 to ensure no aphid damage. Each plot was six foot by six foot. They were planted 22 September 2001 with a reduced tillage cone planter. Akron wheat was planted in all borders around the plots. Each replication was surrounded by a six foot border.

All plots had two subplots of paired one meter rows. These rows were used for sampling. One row was used to destructively sample by growth stage (stem elongation and boot) for determination of actual infestation levels. The other row was for yield analysis. Each paired row was artificially infested using the bazooka method on 10 April 2002. Total RWA on each of the 1x rows was calibrated to be 50 (49.4) and the 10x rate with 500 (486.8) aphids.

Destructive sampling of one half meter began on 02 May 2002 (Zadoks growth stage 30-32). The susceptible variety was showing symptoms of RWA damage. Total tiller counts were taken from each plot. Then counts were taken for the following: asymptomatic and no RWA, asymptomatic with RWA, symptomatic and no RWA, and symptomatic with RWA. After counting the tillers, samples were placed in Berlese funnels for 24 hours to extract the aphids from the plants. The RWA were then counted for each sample. The same procedure as above was followed exactly for the second half of the row meter. This began on 29 May 2002 (Zadoks 47-57) with high aphid pressure. Growth stage variability was largely due to drought conditions experienced throughout the growing season.

Harvesting was done on 01 July 2002 using scissors to cut the heads off of each row meter opposite the destructively sampled row. Total head counts were taken during harvest. Small paper grocery bags were used to store the heads until thrashing began 15 July. An Agriculex SPT-1 thrashing machine was used to separate grain from heads. Each sample was cleaned using a small Rapsco aspirator. Total seed weight was taken and the samples placed in a model 850-2 Old Mill Company seed counter. One thousand seeds were counted and weighed to determine test weight.

RESULTS: This experiment was repeated throughout eastern Colorado. The results in the table show yield comparisons at the Akron, Colorado site. For more information contact Mike Koch at the Central Great Plains Research Station, Akron, Colorado or Dr. Frank B. Peairs at the Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, Colorado. Results will be published in the Colorado Field Crop Insect Management Research and Demonstration Trials Technical Bulletin.

Table. Economic injury level wheat yields for Akron 2002.

Aphid level	Yield (bu/A)			
	0 X	1 X	10 X	Mean
Ankor	31.2 A	28.3 A	24.7 A	28.1 A
Akron	30.4 A	26.6 A	20.4 A	25.8 BA
Halt	28.4 A	23.6 A	24.0 A	25.3 BA
Stanton	27.0 A	23.7 A	19.7 A	23.5 B
mean ¹	29.3 A ¹	25.6 B ¹	22.2 C ¹	

Means in the same column followed by the same letter(s) are not statistically different, SNK ($\alpha=0.10$)

¹This row indicates a statistical difference in mean yield when comparing aphid levels.

FUTURE PLANS: Data from all locations will be analyzed and released for producer review. At the present time, no plans to repeat this study are scheduled.

SPRING BARLEY RUSSIAN WHEAT APHID RESISTANCE STUDY NEAR STONEHAM, COLORADO - DON MAIS FARM

M.D. Koch

PROBLEM: Russian wheat aphid *Diuraphis noxia* (Mordvilko) resistant spring barley varieties developed by USDA-ARS in Stillwater, Oklahoma are being tested throughout the region. Don Mais of Stoneham, Colorado has been influential in helping ensure dryland farmers will have a barley variety with resistance suitable for this area.

APPROACH: The plots were located approximately five miles northeast of Stoneham. It is a harsh environment with less normal precipitation than Akron, Colorado. There is not a weather station near the plot location. However, precipitation through the past year has been significantly less than that of Akron. Barley is drought tolerant but this year was hard on the toughest of plants. There were no aphids artificially introduced to the plots. The information gathered was to aid in reducing the varieties being examined. Once it is determined which are suitable for the climatic conditions, aphid resistance will be evaluated.

The plots were planted 18 March 2002 using a six foot cone planter. Each plot was six foot by six foot with a border around each replication. There were four replicates of twenty varieties in a complete randomized block configuration. Otis barley was used as the check variety. In the event of an economic natural aphid infestation, Otis treated with 8.3 ounces per hundred pounds of imidacloprid (Gaucho) was added to compare with the resistant varieties. There were a few Russian wheat aphids in the plots. No damage was noted and populations remained very low.

RESULTS: Dolores Mornhinweg with the USDA-ARS in Stillwater, Oklahoma has been analyzing data taken on the plots at all locations. For further information on this study contact her at 1301 N. Western Road in Stillwater, OK 74075-2714 or by phone (405)624-4141 extension 237 or Mike Koch at the Central Great Plains Research Station, Akron, Colorado 80720 or phone (970) 345-2259 feel free to leave a message.

FUTURE PLANS: It was a goal of the researchers to reduce the number of varieties being studied by more than half this past year. This spring the experiment will be repeated in the Stoneham area. Resistance to the aphid will be determined on the top yielding five to ten varieties.

SEED YIELD OF SEVERAL SOYBEAN VARIETIES

D.C. Nielsen

PROBLEM: Diversifying dryland production systems in the central Great Plains requires knowledge regarding the productivity of alternative crops. Producers have shown interest in seed production of soybean, yet seed yield for a range of maturity groups grown in this environment is not available.

APPROACH: Three Pioneer seed soybean varieties [(92B38, 92B84, 93B72) maturity groups 2.3, 2.8, 3.7] were evaluated for seed yield. Seeding was done directly into wheat stubble on 17 June 2002 with a Great Plains no-till drill with 15 in. row spacing. Seeding rate was 200,000 seeds/acre. To evaluate effectiveness of using a stripper header for harvest, hand samples are taken for yield prior to combine harvest in 3, 50 ft² areas in each variety, and seeds counted on the ground before and after combine harvest. Combine yield is also measured over the entire 1.25 acre area for each variety.

RESULTS: No yield samples were obtained due to extreme drought.

FUTURE PLANS: We will plant these varieties again to gain more experience with soybeans in this environment, and to improve our use of the stripper header with this crop.

FORAGE YIELD OF SEVERAL SOYBEAN VARIETIES

D.C. Nielsen

PROBLEM: Diversifying dryland production systems in the central Great Plains requires knowledge regarding the productivity of alternative crops. Producers have shown interest in forage production of soybean, yet forage yield and quality information are not available.

APPROACH: One commercial (Donegal) and seven experimental forage soybean varieties along with one commercial maturity group 7 seed variety were evaluated for forage yield and quality. Seeding was done on 18 June 2002 with a Great Plains no-till drill with 15 in. row spacing and at a rate of 200,000 seeds/a. Varieties were planted over an irrigation gradient to provide a range of available water conditions.

RESULTS: Drought, poor stand establishment, poor weed control, and hail resulted in no yield data being collected in 2002.

FUTURE PLANS: Field trials of experimental forage soybean varieties will continue as seed is made available through Dr. Tom Devine, USDA-ARS, Beltsville, MD. Comparisons will be made with the commercial forage variety and the commercial group 7 seed variety.

CROP ROTATION AND TILLAGE EFFECTS ON WATER USE AND YIELD OF ALTERNATIVE CROP ROTATIONS FOR THE CENTRAL GREAT PLAINS

D.C. Nielsen, M.F. Vigil, J.G. Benjamin

PROBLEM: Increased use of conservation tillage practices has made more soil moisture available for crop production in the central Great Plains, thereby providing greater opportunities for more intensive crop production as compared with conventional wheat-fallow. Information is needed regarding water use patterns, rooting depth, water use/yield relationships, precipitation storage and use efficiencies, and water stress effects of crops grown in proposed alternative rotations for the central Great Plains.

APPROACH: Nine rotations [W-F(CT), W-F(NT), W-C-F(NT), W-M-F(NT), W-C-M(NT), W-C-PEA(NT), W-SUN-F(NT), W-M-SUN-F(RT), W-SUN-M-PEA(RT)] are used for intensive measurements of water use and water stress effects on yield. (W:winter wheat, C:corn, F:fallow, M:proso millet, SUN:sunflower, PEA:pea; CT:conventional till, RT:reduced till). Measurements include soil water content, plant height, leaf area index, above ground biomass, grain yield, residue mass and cover, and precipitation.

RESULTS:

Rotation	Crop	ET (in)	Yield (lb/a)	Rotation	Crop	ET (in)	Yield (lb/a)
W-F(CT)	wheat	10.6	1453	W-SUN-F	sunflower	7.8	0
W-F(NT)	wheat	12.6	1842	W-M-SUN-F	sunflower	6.6	0
W-C-F	wheat	12.8	1790	W-SUN-M-PEA	sunflower	8.0	0
W-M-F	wheat	12.0	1698	W-C-PEA	corn	7.1	0
W-SUN-F	wheat	10.7	1342	W-C-M	corn	6.0	0
W-C-M	wheat	7.0	740	W-C-F	corn	6.4	0
W-C-PEA	wheat	6.3	311	W-M-F	millet	3.1	0
W-M-SUN-F	wheat	10.0	1235	W-M-SUN-F	millet	4.5	0
W-SUN-M-PEA	wheat	6.0	317	W-C-M	millet	4.2	0
W-SUN-M-PEA	pea	4.1	27	W-SUN-M-PEA	millet	4.0	0
W-C-PEA	pea	4.5	28				

INTERPRETATION: Growing season precipitation was much below normal (wheat=5.2", pea=2.9", sunflower=5.9", corn=5.4", millet=3.8"). Consequently, no yield was produced by sunflower, corn, and millet. Pea and wheat yields were low. Wheat yields were correctly predicted by soil water availability using a previously defined relationship for extremely dry years ($bu/a = 13.35 + 1.5 * avail. water$), but only for available water amounts greater than 6.5 inches. Actual yields for drier starting soil water situations (W-C-M, W-C-Pea, W-Sun-M-Pea) were far below predicted yields due to the extreme drought (pan evaporation - precipitation for April, May, and June = 38.4").

FUTURE PLANS: Experiment to continue as in past years with no significant changes. Modeling of yield and water use from this experiment was begun in 2002 with RZWQM and DSSAT-CERES-Wheat, and will continue in 2003. Evaluations of corn, sunflower, and millet models will also be started. Effects of starting water content at planting on yield of corn and sunflower will be published.

WINTER WHEAT VARIETAL YIELD DIFFERENCES RELATED TO CANOPY TEMPERATURE DIFFERENCES AND SOIL WATER USE

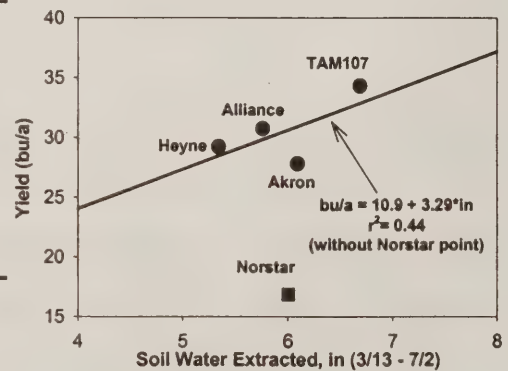
D.C. Nielsen

PROBLEM: Drought stress regularly limits winter wheat yield in the central Great Plains. I hypothesize that varieties that are better able to maintain their non-water-stressed canopy temperatures under water stress will yield higher under water stress than varieties which do not maintain their non-water-stressed canopy temperature under water stress. Monitoring of stressed and non-stressed canopy temperatures will therefore be a quick screening tool to identify varieties adapted to drought stress.

APPROACH: Twelve varieties of winter wheat (TAM107, Jagger, Arlin, Prowers, Siouxland, Akron, Alliance, Norstar, 2137, Heyne, Halt, Yumar) were grown in small plots (15' by 40') under two water treatments (rainfed and full irrigation), replicated three times. Canopy temperatures were monitored daily with an infrared thermometer between 1300 and 1400 MDT. Cumulative difference between canopy temperatures of rainfed and fully irrigated plots was compared to dryland grain yield and biomass for each of the twelve varieties. Soil water was measured in five varieties on 13 Mar, 20 May, 6 Jun, and 2 Jul 2002 to assess differences in soil water extraction.

RESULTS: March through June rainfall (2.83 in.) was 36% of average, fairly evenly distributed (0.96" during vegetative, 1.05" during head extension to milk, 0.83" during grain-filling). Consequently we were afforded the opportunity of evaluating differences in yield due to soil water extraction for the five varieties where soil water was measured.

Variety	Dryland -----bu/a-----	Irrigated	Variety	Dryland -----bu/a-----	Irrigated
Akron	27.9	62.9	Norstar	17.0	53.9
Alliance	30.9	82.8	Prowers	28.5	73.6
Arlin	26.1	83.1	Siouxland	30.9	76.5
Halt	35.8	82.0	TAM107	34.5	88.6
Heyne	29.4	68.9	Yumar	26.1	77.0
Jagger	34.9	77.5	2137	30.7	76.9



INTERPRETATION: Clearly Norstar is not a variety adapted to the high temperature, high vapor pressure deficit conditions of the central Great Plains.

For the other four varieties for which soil water was measured, there appears to be a relationship between yield and soil water extracted during the growing season. TAM107 was able to extract about 0.6" more soil water during the heading to milk stage period than the other three varieties (data not shown), and extracted 1.3" more water than Heyne over the entire spring and summer growth period. Most of this higher water extraction was noted from the 6th foot of the soil profile, indicating that part of TAM107's greater drought tolerance is derived from greater rooting depth/volume.

FUTURE PLANS: The experimental results will be written for publication in 2003.

SIMULATING CORN, SOYBEAN, AND WHEAT YIELD AND DEVELOPMENT UNDER VARYING WATER, NITROGEN, AND PLANTING DATE CONDITIONS WITH RZWQM AND DSSAT MODELS

D.C. Nielsen, L. Ma, Saseendran S.A., L.R. Ahuja

PROBLEM: Dryland agricultural production in the central Great Plains is diversifying and intensifying from the traditional wheat-fallow system. Corn has already been added to many rotations, and soybean has been proposed as a possible alternative crop. Computer models exist which could be used to simulate growth, development, and yield of both of these crops and others. But these models have not been adequately calibrated and tested under the limited and variable water conditions of the central Great Plains in which water stress frequently affects plant development and yield.

APPROACH: The Root Zone Water Quality Model (RZWQM), and CERES-Maize, CERES-Wheat, and CROPGRO-Soybean as used in the Decisions Support System for Agrotechnology Transfer (DSSAT) were calibrated and evaluated using corn, soybean, and wheat data collected from line-source, gradient-irrigation experiments and dryland nitrogen fertility experiments conducted at Akron, CO during several growing seasons. Plant height, leaf area, phenological development, soil water extraction, water use, dry matter development, and grain yield were measured and compared with computer model simulation results.

RESULTS: RZWQM simulated corn, soybean, and wheat yield acceptably under all water availability conditions, and provided somewhat better simulation of soil water content than the DSSAT models.

FUTURE PLANS: The results of the corn and soybean comparisons made under varying water availability conditions have been published. The results of the wheat comparisons made under varying nitrogen variability have been submitted for publication. The comparisons of the fully irrigated corn made under varying planting dates are partially completed. Future plans call for region-wide evaluations of soybean as an alternative crop using the calibrated models, as well as simulations of various crop rotations and identification of best adapted crop sequences.

INSECTS IN DRYLAND CROPPING SYSTEMS AT BRIGGSDALE

D.J. Poss

PROBLEM: The Russian wheat aphid (RWA) has become a major pest in small grains in Colorado. Cultural, mechanical, chemical, and biological control methods are all possible. Chemical control has been the most effective. However, it is costly and is not a long term solution. Combining cultural and biological controls may be the best choice. A diverse cropping system may promote an environment in which the predators can survive.

APPROACH: In 1999 an experiment was set up near Briggsdale, Akron, and Lamar, CO to study the impact more diverse cropping systems have on RWA and its predators. This report focuses on the Briggsdale site which is located 3 miles south of Briggsdale. The plots are 0.85 acres in size. Russian wheat aphid and its predators are the primary insects we are studying. Common pests in the other crops are also monitored. The hypothesis is that with a more diverse system predatory insects (specifically those that prey on RWA) will move to prey on other crops. In a Wheat/Fallow system there is approximately a 12 week period between dry down of a wheat crop to emergence of the following crop. Most predators life cycle is much shorter than this, making it difficult for them to survive. By introducing more crops to a system there is a green bridge. In other words there is a green crop growing when there is no green wheat present that the predator insects can move into and prey on the insects in that crop. The rotations at Briggsdale include a Wheat/Fallow rotation which has been the traditional rotation in the area for decades; a Wheat/Millet/Fallow rotation which is becoming a more common rotation for the area; and a Wheat/Wheat/Corn/Corn/Sunflower/Fallow rotation. The six year rotation allows us to examine how nontraditional crops will do in this area. The two primary crops in this area are wheat and millet. It would be beneficial to the producers if we could find other crops that will grow in this area.

RESULTS: 2002 was a record dry year at Briggsdale, similar to most of Colorado. Precipitation was less than half of average during the wheat growing season and slightly over half during the corn growing season (Table 1). However, 3.65 inches of the 6.43 inches of precipitation was received in September after the corn was nearly dead. The Briggsdale area has a dry climate with the average precipitation equal to 13 inches per year. When the total is less than half the average, producing viable crops becomes very difficult.

Table 1. Precipitation during selected period in 2001/2002 at Briggsdale.

		<u>2001/2002</u>	<u>Average</u>
Wheat	Sept. 2001 - June 2002	4.17	9.26
Spring crops (Pre-plant)	July 2001 - April 2002	5.15	9.48
Spring crops (Growing season)	May 2002 - Sept. 2002	6.43	9.87

Wheat yields were low due to the drought, ranging from zero to nearly 20 bu/ac. A nearly full soil profile of soil water allowed the wheat crop to produce the yield it did, even though the amount of precipitation received during the growing season was well below average. This is evident when looking at the stored soil water at wheat planting. Total soil water in the WF and WMF rotations was approximately 10% (Table 2). The first year wheat in the W'WCCSf rotation also

had fallow, however the crop in 2000 was sunflowers which has the ability to deplete the soil of water and nutrients to lower levels than most crops. Also, the soil in this treatment had very little cover compared to the second year wheat (wheat following wheat) which may have allowed this rotation to have approximately the same soil water at planting.

Table 2. Percent total soil water in top six feet of soil at planting at Briggsdale in 2002.

<u>Wheat</u>		<u>Spring planted crops</u>	
WF	9.9a	Corn1	6.8b
WMF	10.4a	Corn2	8.9a
W'WCCSfF	6.3b	Sunflower	8.4a
WW'CCSfF	7.1b	Grain Sorghum	8.1a
		Millet	8.9a

Table 3. Wheat Yields at Briggsdale in 2002 by rotation.

<u>Rotation</u>	<u>Yield (bu/ac)</u>
WF	19.4a
WMF	18.2a
W'WCCSfF	0
WW'CCSfF	4.9b

Yields for all other crops were also very low. No spring planted crops were harvested for grain. Total biomass yields were taken for all crops. Foxtail millet did well considering the drought with a yield of 1,570 lb/ac. Corn was planted into two treatments, following wheat and following corn. The corn biomass yield following corn was much better than following wheat (2,600 lb/ac vs. 930 lb/ac). If you look at the soil water at planting (Table 2) those yields correlate with biomass yield. Also, the corn in the wheat stubble was obviously better where the combine drove during wheat harvest the previous year. In this area the combine left more chaff which resulted in more cover and less evaporation in this area. Grain sorghum biomass yielded 820 lb/ac. This was our first attempt at grain sorghum at Briggsdale. Three of the four plots had a severe witchgrass and stinkgrass infestation. The plot that had good weed control looked good enough that we may consider trying grain sorghum again in the future. Sunflowers died shortly after emergence, so no yield was taken.

Only a few insects were found in wheat in 2002. Those that were found were brown wheat mite, army cutworm, and pale western cutworm. No insects were found in the other crops. Beneficial insects are scouted for and monitored several times for each crop. No beneficial insects were found during the timed scouting periods.

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BUILDING ECOLOGICAL SITE DESCRIPTIONS IN THE NORTHERN PLAINS REGION: A TEAM APPROACH

Josh Saunders, Natural Resources Conservation Service

PROBLEM: Range site descriptions have provided ecologically based guidance in making land management decisions for more than 60 years. However, a greater understanding of ecosystem dynamics coupled with an emerging host of new landowners, non-traditional uses, and management objectives have resulted in the transition to ecological site descriptions (ESD).

APPROACH: In August of 1999, the Natural Resources Conservation Service (NRCS), using the protocol outlined by the National Range and Pasture Handbook, developed a comprehensive seven-year plan to convert all existing range and woodland site descriptions within the Northern Plains Region (Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Wyoming) into ecological site descriptions.

The task is immense but attainable. More than 180 NRCS employees in the Northern Plains Region will be called upon to develop over 2000 ecological site descriptions, covering 53 Major Land Resource Areas (MLRA), 18 states, and three adjacent regions. Coordination, communication, and commitment are key to the success of the project.

Specific to each MLRA is a group of individuals known as the "Local Work Group." These individuals are typically field people who have years of experience and a wealth of technical knowledge. Together, they work as a team with other coordinators and specialists to build the foundation of this new rangeland/woodland management tool.

The major responsibility of the Local Work Group is to develop species composition tables, state and transition diagrams, and written narratives to support and explain the various plant communities, transitional pathways, and ecological thresholds. These three components are the focal points of each ESD.

Partners such as Agriculture Research Service (ARS), Bureau of Land Management (BLM), Forest Service, Universities, local, state, private entities, and other end users are continually involved in the development and review process.

RESULTS: Development began in January of 2000. As of January 2002, the Northern Plains Region has initiated work on 12 MLRA's ranging from 2 - 95% complete.

FUTURE PLANS: All ecological site descriptions in the Northern Plains are scheduled to be complete by the end of 2006. Progress continues to be steady and ongoing. Changes in NRCS policy and retirement of experienced field specialists are major challenges. Future ESD's will be uploaded to an NRCS web site for public access. Upon completion, ecological site descriptions will provide the foundation that will assist land managers in making timely, well informed resource management decisions on rangeland and forest land.

RESPONSE OF IRRIGATED SUNFLOWERS TO WATER TIMING

Joel P. Schneekloth, CSU Regional Water Resource Specialist

INTRODUCTION: With declining water supplies in the central Great Plains Region, water conservation is an important issue for producers. Many areas have reported declining groundwater levels for 20 or more years within Colorado, Kansas and Nebraska. As groundwater levels decline, well output has declined in some regions to the point that systems are limited in their capability to fully irrigate a single crop under the entire system. Sunflower is a crop that has been proven to be beneficial to dryland producers because of its drought tolerance. However, little is known about the responsiveness of sunflowers to limited water and the timing of water needs for that crop.

METHODS AND MATERIALS: An experimental site was developed at the U.S. Central Great Plains Research Station at Akron, CO. Soil was a Weld silt loam (fine, smectitic, mesic, Aridic Argiustolls) with a plant available water holding capacity of 2 inches per foot. The previous crop was rainfed corn in 2001. Sunflowers were planted May 23, 2002 no-till into corn stubble. Varieties planted were Triumph 658 Nu-Sun for oil and Triumph 765C for confectionary. Planting rates were 24,000 seeds per acre for oil and 21,000 for confectionary in 30-inch rows. Fertilizer application was 100 lbs/acre of nitrogen and 30 lbs/acre of phosphorous. Furadan was applied at 1 quart per acre in-furrow at planting for stem weevil control. Herbicide application was Spartan at 2.3 oz/acre and Round-up at 20 oz/acre applied on May 15, 2002 and hand weeding for weed escapes.

A split-plot design was used for this experiment with timing of water application being the main plot with sunflower type (oil vs confection) as the sub-plot. Main plots were 15 ft (6 rows) by 130 feet with 4 replications with sub-plots 65 feet long. Water was applied with a surface drip system on 60-inch centers. The application rate of the system was 0.08 inches per hour and operated to apply 0.8 to 1.0 inches per application. Soil moisture was monitored weekly with the neutron attenuation method to a depth of 5 feet in 1 foot increments for each treatment. Plots were hand harvested on October 8, 2002. The middle two rows of plots were harvested for a total row length of 20 feet.

RESULTS: Weather: Precipitation for the cropping year of 2002 was characterized as below normal for a majority of the growing season (Table 1). Precipitation for the year (October 2001 – September 2002) was 57% of normal. Approximately 50% of the yearly precipitation occurred in August and September of 2002. Precipitation from May to July, during the vegetative growth stage, was less than 35% of normal. Dry weather and soil conditions hampered germination of seeds after planting. On August 24, three separate hailstorms caused severe damage to the sunflower crop. Reduction in leaf area was estimated to be greater than 90%.

Grain Yield: Grain yields and test weights for confection and oil sunflowers are reported in Table 2. Irrigation amounts are reported in Table 3. Grain yields were found to increase with the increased amount of water applied to both confection and oil sunflowers. Fully irrigated oil sunflowers yields were greater than limited irrigation oil sunflower. Yields of confection sunflowers were similar when irrigation began during the R1 growth stage or earlier. If irrigation was delayed to R4 growth stage or later, grain yields were reduced. Yields for both confection and oil sunflowers were greater when irrigation was initiated at R1 growth stage or before, rather than during later growth stages. Grain yields for oil sunflowers, when irrigation was initiated prior to the reproductive growth stage, were greater than yields when irrigation was initiated at R1. This was due to the lack of stored soil

moisture and precipitation during the vegetative growth stages.

Test Weight: Test weights (Table 2) for irrigated confection sunflowers were not statistically different. Rainfed confection sunflowers generally had a lower test weight than irrigated. There was a tendency for test weight to increase when water was withheld during the early reproductive growth stages for confection sunflowers. When irrigation was initiated on or after R4 growth stage, test weights were generally more than when irrigation was initiated at R1 regardless of the length of time irrigation was continued.

Test weights for oil confections generally increased the later irrigation was initiated during the reproductive growth stage. However, the lowest test weights occurred when irrigation was initiated during the R1 growth stage. Test weights for both confection and oil sunflowers were more when irrigation was initiated during the R6 growth stage followed by the R4 growth stage.

Irrigation Water Use Efficiency: The efficiency of each irrigation strategy is important in limited water management. Irrigation water use efficiency (IWUE) is defined as the following:

$$\text{IWUE} = \frac{\text{Irrigated Yield} - \text{Rainfed Yield}}{\text{Irrigation Amount}}$$

The IWUE shows how efficient irrigation water applied during each growth stage was converted to grain yield. A higher IWUE value indicated each inch of irrigation applied was converted to more grain production.

Maximum IWUE for both confection and oil sunflowers occurred when the crop was irrigated during the R1-R3 growth stages. Each inch of water applied at this growth stage was converted to approximately 190 lbs/acre of seed. With confection sunflowers, the longer and more irrigation water was applied, the IWUE decreased, indicating that maximum yield was being approached while oil sunflowers IWUE response decreased slightly.

CONCLUSIONS: 2002 was historical in terms of drought and was the driest year on record. Sunflowers yields responded positively to additional water applied through irrigation. Oil type sunflowers tended to have greater yields than confectionary under rainfed and full water management. Yields under limited water for both confection and oil sunflowers were similar.

A hailstorm on August 24, 2002 and dry weather during emergence limited the yield potential for the irrigated sunflowers. Changes that are planned include watering the sunflowers after planting with a hand-move sprinkler system to ensure adequate germination.

Table 1. Yearly precipitation for Oct 1, 2001 to Sept. 30, 2002 by month and long-term average precipitation.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Inches												
Yearly	.63	.78	.00	.09	.06	.08	.50	.55	1.71	.10	3.44	1.50
Average	.90	.55	.40	.33	.34	.83	1.64	2.96	2.45	2.67	2.08	1.23

Table 2. Grain yield and test weight for oil and confection sunflowers irrigated at different growth stages.

	Oil Type Sunflowers		Confectionary Type Sunflowers	
	Grain Yield	Test Weight	Grain Yield	Test Weight
Rainfed	468 D	23.2 AB	299 D	20.9 B
R6-R7	771 CD	25.2 A	688 C	24.7 A
R4-R5	1022 BC	24.7 AB	883 BC	23.4 AB
R1-R3	1326 B	22.3 B	1137 AB	22.8 AB
R1-R8	1287 B	22.7 AB	1192 A	22.6 AB
Full Water	1981 A	23.8 AB	1335 A	22.8 AB

Treatments within a column followed by the same letter are not significantly different (PR>.05).

Table 3. Irrigation amounts and irrigation water use efficiency for irrigated oil and confectionary sunflowers.

	Irrigation Amounts	IWUE Oils	IWUE Confec.
Treatment	Inches	Lbs/Acre-Inch	Lbs/Acre-Inch
Rainfed	0		
R6-R7	2.6	116.5	149.6
R4-R5	3.7	149.7	157.8
R1-R3	4.5	190.7	186.2
R1-R8	6.4	128.0	139.5
Full Water	9.0	168.1	115.1

LEGUME N CREDITS IN WINTER WHEAT LEGUME ROTATIONS

M.F. Vigil, D.C. Nielsen, R.A. Bowman.

PROBLEM: With the exception of water, nitrogen (N) nutrition is the most important limiting input to profitable winter wheat production in the central Great Plains. Increases in N fertilizer costs have caused some farmers to consider alternative systems that include legumes as a source of N. Farmers need to know how these systems impact winter wheat yields, economic returns and N availability. The two sites previously established in which the main plots consist of legume species: Austrian winter peas, spring field pea (cv. Profi), Hairy Vetch and a no-legume-summer-fallow (SF) (plot fertilized at four N rates 0, 30, 60, and 90 lb N/ac are now being used for a two year follow up study. The objectives of the follow up experiment are (1) to determine the fertilizer N response of wheat following the legumes, (2) to determine the N response of the legumes and (3) to determine the difference in N response of the legume wheat rotation as compared to wheat fallow.

APPROACH: Legumes are planted early in April or late March. Weeds growing in the fallow plot are allowed to grow and use water until the legumes are terminated. Legumes and weeds in summer fallow are terminated at the same time, usually the first or 2nd week of June. Before planting wheat in legume stubble each fall, the legume plots are divided into 4 subplots and each subplot is fertilized with either 0, 30, 60, and 90 lb N/ac. Soil inorganic N is measured in each plot, at each termination date, in the top 3 feet of soil, and at wheat planting time to monitor changes in available N. Just after fertilizing legume stubble, wheat is planted. Grain yield is measured using standard BMP's for dryland winter wheat. Equations are fitted to the wheat-grain-yield-response to added N fertilizer for the legume-wheat plots and the wheat-fallow plots. If there is a legume N credit the N response curve for wheat following the legume plots should be higher on the vertical axis than the fallow N response curve. This is assuming that the weeds use the same amount of water as the legumes.

RESULTS: This past year (2002) wheat yields were less than previous years (Table 1). Nitrogen rates of 30 and 60 lbs/acre increased wheat biomass yields but didn't always show a significant increase in grain yields. In the wheat plots after fallow, (SF) the highest yields were at the 60 lb N rate (49 bushel/acre). On the other hand, in wheat plots following legumes the highest yields were measured in the check plot with no fertilizer. The lowest yields were measured in wheat following Profi-pea (table 2).

Earlier in the experiment, we found that 88 % of the variability in wheat yield loss could be described by an equation based on the previous year's legume water use (ET). Generally the highest yield reductions were with the later termination dates. Sometimes the earliest termination dates did not result in a significant reduction in grain yield. Legume green fallow increases wheat-grain-N contents similar to fertilized summer fallow. However, the increase does not increase wheat yield and or cause a large increase in grain-N-uptake when compared to traditional summer fallow. In last years' experiment, we are seeing a similar result. It is interesting that biomass yields tended to increase with added N but didn't always result in increased grain yield. We suspect, greater-early-season water use with the 60 and 90 lb N rate plots (bigger plants use more water than smaller ones) than with the 0 and 30 lb N rates. Perhaps less water is available in those plots later in the season during grain filling which depressed yield.

Table 1. Wheat yields as affected by N rate and previous years fallow management in 2001 and 2002.

Treatment		Wheat grain yield		Wheat biomass yield	
Last years fallow management	N rate	bushels/acre		lbs/acre	
	lbs/acre	2001	2002		
Fallow	0	41	36	6500	5200
‘ ‘ ‘	30	44	39	7500	5500
‘ ‘ ‘	60	49	41	7800	6000
‘ ‘ ‘	90	44	44	8400	6000
Austrian winter pea	0	43	27	7200	3600
‘ ‘ ‘	30	38	28	6500	3800
‘ ‘ ‘	60	39	30	7600	4300
‘ ‘ ‘	90	32	28	7800	3500
Hairy Vetch	0	40	30	6900	3900
‘ ‘ ‘	30	35	28	6500	3600
‘ ‘ ‘	60	36	33	7100	4500
‘ ‘ ‘	90	36	29	7000	4000
Profi pea	0	35	33	6300	4100
‘ ‘ ‘	30	29	32	6800	4500
‘ ‘ ‘	60	30	28	7400	4800
‘ ‘ ‘	90	29	34	8200	5200
LSD (0.05)		9	7	1400	1100

Table 2. Wheat yields as affected by fallow treatment in 2001.

Treatment	Wheat Grain yield	Wheat Biomass
Last years fallow management	bushels/acre	lbs/acre
Fallow	44.3	7600
Austrian winter pea	38.1	7300
Hairy Vetch	36.7	6900
Profi pea	30.1	7200
LSD (0.05)	4.4	698

FUTURE PLANS: We will conduct the follow up experiment for another year. Four publications have resulted from the study.

TRITICALE THE NINETEENTH CROP OF A DRYLAND ROTATION WITHOUT SUMMER FALLOW

M.F. Vigil, R.A. Bowman, A.D. Halvorson

PROBLEM: Conservation tillage has increased annual soil water storage. This enables the use of annual cropping for some soils of the central Great Plains. Annual cropping entails greater biomass production which increases surface crop residues impacting soil quality and soil water storage. This study was designed to evaluate long term changes in soil C and N under annually cropped dryland conditions under different N fertility. Short term, the study allows for the estimation of N use efficiency and fertilizer N requirements of various dryland crops.

APPROACH: This is the 18th year of the experiment (started by Ardel Halvorson in 1983), where under dryland conditions, the site is cropped continuously with no summer-fallow on a Weld silt loam. The site was a barley-corn rotation until 1992 when oats for hay replaced barley. We have had 15 successful years and three failures in the 17 years of cropping: winter wheat was grown in 1988 to replace a hailed out corn crop in 1987, in 1990, poor stand and aphids limited barley yields to 21 bu/acre, and in 2000, Round-up-ready-soybeans (category 3) made between 8 and 13 bushel. The experiment is a 4-rep RCB where the only treatment is N fertilizer rates of 0, 20, 40, 60, 80 or 120 lbN/acre. The study is managed with no-till to conserve water, and weed control has been through the use of contact and residual herbicides. Phosphorous (P) nutrition has not been limiting but low rates of P have been applied with the seed at planting or as broadcast treatments. Soil profile water and nitrates are monitored annually to determine N balance and water use efficiency.

RESULTS: In 2002, triticale biomass yields were less than 500 lbs/acre due to drought. In 2001 roundup ready (DK493)Corn made 87 bushel with 80 lbs of N (table 1). Yields tended to increase with increasing N rate. Through the years, the optimum N rate for the grain crops has been between 40 and 60 lbs N/acre for wheat and between 60 and 80 lbs for corn.

Table 1. Yields of dryland corn as affected by N rate in 2001 under no-till annual cropping.

N rate	Grain Yield	Test wt
lbs /acre	bushels/acre	lbs/bushel
0	68	55
20	77	55
40	81	55
60	85	55
80	86	54
120	88	54

A buildup of excess nitrate-N can be found in the soil of plots fertilized at 80 lbs or more. These results suggest that with this soil (under dryland conditions) annual fertilizer N rates greater than 80 lb/acre, are excessive for the crops and management currently available. Triticale yields in 1995 were 5.5 ton/acre at an optimal N rate of 80 lb/acre. In 1996, maximum corn grain yields of 90 bu/acre

were measured at the 120 lb N rate. At the 80 lb N rate 75 bu/acre of grain was harvested. In 1997, on 11, July we harvested 900 to 1100 lbs of profi peas with a whole plot average of 1011 lbs/acre. The 1998 crop of winter wheat averaged 26 bushels in the fertilized plots and 22 bushels in unfertilized plots. Corn yields in 1999 were as high as 140 bushels per acre at the 80 and 100 lb N rates. Warm season grasses (sandbur) are becoming a nuisance. In 2000, roundup ready soybean (maturity group 3) was used to help eliminate the sandbur problem. The soybeans were not fertilized with N because residual N levels were large from fertilization in prior years. A visual response of the soybean was observed. The lowest yields were measured in the 80 and 120 lb N/acre plots (8 bushel/acre). The largest yields were measured in the 0 N-rate plot (13 bushel/acre).

FUTURE PLANS: The crops for the next few years will be dormant seeded winter wheat or spring triticale, Round-up ready corn and dry edible beans or millet. The experiment will continue for another 4 years to evaluate long-term soil C and N changes under high N management and high productivity.

NITROGEN RESPONSE OF WHEAT, CORN AND SUNFLOWERS IN A DRYLAND ROTATION ROW SPACING EFFECTS

M.F. Vigil, J.G. Benjamin, J. Schepers,

PROBLEM: The current demand for edible oils has improved the profitability of sunflowers in the Central Great Plains. However, knowledge of sunflower response to fertilizer N in the region is limited. The objectives here are: (i) to measure sunflower N response in a no-till wheat-corn-sunflower-fallow rotation, (ii) to determine N fertilizer recovery of this crop as affected by fertilizer placement method, and (iii) to compare narrow row (20") production with conventional spacing.

APPROACH: Sunflower is planted and fertilized in a split-plot 4-rep experiment. Main plots consist of rotation crop/phase (sunflowers, corn, wheat or fallow). Sub-plots are fertilizer N rates of 0, 30, 60, or 90 lb N/acre. Sunflowers are planted in either **20 or 30 inch rows**. A seeding rate of 16,600 seeds per acre is used for both row spacings. In the 20 inch row plots, 2 rows are sprayed at the 5th leaf stage and at the early-bud stage with zinc, copper, manganese and boron. Individual plots are 60 ft by 240 ft in size. Surface and deep placed ¹⁵N labeled fertilizer is used to evaluate fertilizer N recovery with soil depth and N placement method.

RESULTS: In 2002 no corn or sunflowers were harvested due to drought. We summarized the N rate effects on sunflowers and found that Sunflowers need about 6-7 lbs of N per 100 lbs of grain production. Sunflower grain yields have averaged around 1000 lbs/acre. Only one year out of 7 have we measured a sunflower grain yield response to added N fertilizer (1999). In 2001, a small increase in grain yield to added N was measured in corn. Wheat has always, responded well to added N. We measured 60 bushel wheat at the 60 and 90 lb N rates with Trego white wheat. No significant yield response due to row spacing was measured. In this study we have had 2 years in which row spacing has not had an effect on yield and one year that it has. In all years, there is a suppression of weed growth that is visually noticeable in the narrower rows. In 2000, a dryer than normal summer with low preplant soil water contents, we measured less than 300 lbs of grain in our best sunflower plots. No row spacing, N rate, or micronutrient responses were detected in 2000 with either sunflowers or corn. Water was more limiting than these other management factors.

FUTURE PLANS: The experiment will be continued for another 4 years to evaluate long term effects of intensive wheat-corn-sunflower fallow rotations and to continue to evaluate N and row spacing effects on yield. We are considering splitting the plots between soybeans and sunflowers, but can't do that until we have finished evaluating the row spacing effect for at least 2 more years.

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